

REMARKS

Applicant hereby requests further consideration of the application in view of the amendments above and the comments that follow.

I. Applicant Elects Claims 1-36 and 46-48

This will serve to confirm that Applicant is electing Claims 1-36 and 46-48, without traverse, in response to the restriction requirement. Consistent with this election, Applicant has cancelled Claims 37-45 without prejudice.

II. Response to the Rejections under Section 112

Claims 3, 13-14, 16, 23, 32 and 36 stand rejected under 35 U.S.C. § 112, ¶ 2 as including terms that do not have sufficient antecedent basis. Applicant has amended each of these claims to correct the informalities identified by the Examiner.

Claims 11 and 15 stand rejected under 35 U.S.C. § 112, ¶ 2 for "failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention" because the Examiner found that the claim term "pre-selected" was indefinite. Applicant has amended Claims 11 and 15 to remove any ambiguities regarding the intended scope of those claims.

III. Response to the Rejections under Section 103

A. The Section 103 Rejections

Claims 1, 2, 5, 10-12, 15, 17, 20, 24-25, 29, 33-36 and 46-47 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkashov (U.S. Patent No. 4,978,556) in view of Davis (U.S. Patent No. RE 34,861). Claims 3-4, 6-9, 14, 16, 23, 26-28 and 30-32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkashov in view of Davis and further in view Kuehnle (U.S. Patent No. 5,879,518). Claims 3-4, 6-9, 14, 18-19, 23, 26-28, 30 and 32-36 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkashov in view of Davis and further in view Smalley (U.S. Patent No. 5,227,038). Claim 13 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkashov in view of Davis and further in view Jaussaud (U.S. Patent No. 6,113,692). Claims 18-19 stand rejected under 35

U.S.C. § 103(a) as being unpatentable over Pinkashov in view of Davis and further in view Fey (U.S. Patent No. 4,582,004). Claims 21-22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkashov in view of Davis and further in view Otsuki (U.S. Patent No. 6,090,733). Finally, Claims 22 and 48 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkashov in view of Davis and further in view Kijima (U.S. Patent No. 5,093,039).

B. Applicant's Claim Amendments

Applicant has amended each of the independent claims. In particular, Applicant has amended independent Claim 1 to include the recitations of Claim 6 and has amended independent Claim 24 to include the recitations of Claims 6 and 25. Additionally, independent Claim 33 has been amended to recite "using resistive or inductive heating to heat a furnace to a temperature below the temperature at which silicon carbide sublimates" and "using an electric arc to create a local high temperature zone within the furnace . . . while maintaining the inner walls of the furnace at a temperature below the temperature at which silicon carbide sublimates." For the reasons discussed below, Applicant respectfully submits that in light of these amendments the pending claims are patentable over the cited art.

Otherwise, Applicant has amended the claims to address the restriction requirement and the rejections under Section 112, as well as to cancel claims that have been rendered superfluous in light of the amendments to the independent claims.

C. Independent Claims 1 and 24 are Patentable Over the Combinations of (1) Pinkashov, Davis and Kuehnle and (2) Pinkashov, Davis and Smalley

To establish a prima facie case of obviousness, the prior art reference or references when combined must teach or suggest *all* the recitations of the claims, and there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. M.P.E.P. § 2143. The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination.

M.P.E.P. § 2143.01, citing *In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d 1430 (Fed. Cir.

1990). As emphasized by the Court of Appeals for the Federal Circuit, to support combining references, evidence of a suggestion, teaching, or motivation to combine must be **clear and particular**, and this requirement for clear and particular evidence is not met by broad and conclusory statements about the teachings of references. *In re Dembiczak*, 50 U.S.P.Q.2d 1614, 1617 (Fed. Cir. 1999). The Court of Appeals for the Federal Circuit has also stated that, to support combining or modifying references, there must be **particular** evidence from the prior art as to the reason the skilled artisan, with no knowledge of the claimed invention, would have selected these components for combination in the manner claimed. *In re Kotzab*, 55 U.S.P.Q.2d 1313, 1317 (Fed. Cir. 2000).

Applicant submits that neither the Kuehnle or the Smalley references can properly be combined with the Pinkashov and Davis references as a skilled artisan simply would not have been motivated to combine the references in the manner suggested in the pending rejections. As such, the rejections of independent Claims 1 and 24 should be withdrawn.

1. **The Rejections Based on Pinkashov, Davis and Kuehnle**

As noted above, both independent Claims 1 and 24 have been amended to include the recitations of Claim 6. In the Office Action, Claim 6 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkashov in view of Davis and Kuehnle. However, for the reasons discussed herein, Applicant respectfully submits that original Claim 6 is patentable over the combination of Pinkashov, Davis and Kuehnle and, as such, the rejections of Claims 1 and 24 should be withdrawn in light of Applicant's amendments to those claims to include the recitations of original Claim 6.

The pending rejections of original Claims 1 and 24 rely on the Pinkashov reference as teaching all of the recitations of those claims except for the use of a silicon carbide seed. (See Office Action at 5-7). The Office Action relies on the Davis reference to provide this teaching. (*Id.*). The Office Action further states that the Kuehnle reference, taken in conjunction with Pinkashov and Davis, "inherently" discloses the recitation of original Claim 6 of "controlling the power dissipated across

the gap to control the flow of vaporized Si, Si₂C and SiC₂ from the silicon carbide electrode to the seed crystal." (Office Action at 8). Applicant respectfully submits, however, that the Kuehnle reference cannot properly be combined with the Pinkashov and Davis references to reject original Claim 6 for at least the following four independent reasons.

First, the Pinkashov reference, as interpreted in the Office Action, discloses a process for using electric arc vaporization to grow silicon carbide semiconductors. In fact, according to the Office Action the Pinkashov reference teaches all of the elements required to perform the method of growing silicon carbide via electric arc sublimation recited in original Claim 1 except that it is silent on the type of seed to use. To the extent this interpretation of the Pinkashov reference is correct, there obviously would be no reason or motivation for the skilled artisan to modify the Pinkashov reference as suggested in the Office Action. However, the rejection set forth in the Office Action assumes that the skilled artisan would, based on the Kuehnle reference, modify the methodology of Pinkashov to maintain a constant gap between the electrodes. Nothing in either the Pinkashov or Davis reference suggests that such a modification would be beneficial, and Applicant submits that it is only through hindsight based on the teachings of the present invention that one would modify Pinkashov based on the Kuehnle reference to find an "inherent" disclosure of the recitation of original Claim 6.

Second, an examination of the cited references makes clear that the Pinkashov reference teaches away from the combination of the Pinkashov, Davis and Kuehnle references used to reject original Claim 6. Specifically, the Pinkashov reference teaches that "arc vapor deposition" of silicon or silicon carbide onto a substrate is accomplished by repeatedly striking the two electrodes together and then separating the electrodes to form an arc between them. (Pinkashov at Col. 1, lines 34-45 and Co. 3, lines 49-60). In the example set forth in Pinkashov, an arc is formed approximately one time per second through this intermittent movement of one or both of the electrodes. (Pinkashov at Col. 4, lines 27-28). The skilled artisan would not have been motivated to ignore these teachings and instead perform electric arc sublimation

by maintaining the electrodes at a fixed distance. This is particularly true as none of the cited references teach or suggest maintaining the electrodes at a fixed distance when performing an electric arc sublimation process (as opposed to some other electric arc process, such as the process for collecting consistently sized nanoparticles disclosed in the Kuehnle reference). Thus, Pinkashov teaches directly away from maintaining the electrodes at a fixed distance and, as such, the skilled artisan would not be motivated to modify the teachings of Pinkashov based on Kuehnle.

Third, the rejection of original Claim 6 should also be withdrawn because the Kuehnle reference is not analogous art. To qualify as analogous art, a reference must either (1) be from the same field of endeavor as the invention at issue, regardless of the problem addressed or (2) be reasonably pertinent to the particular problems with which the inventor is involved. *See, e.g., In re Paulsen*, 31 U.S.P.Q.2d 1671, 1675-76 (Fed. Cir. 1994). The Kuehnle reference does not satisfy either prong of this test.

As to the first prong of the analogous art test, the present invention is directed to the growth of semiconductor materials on a seed crystal or substrate. In contrast, the Kuehnle reference is directed to "a method for producing small particles, e.g., nanoparticles, which have consistent size, shape, structure and functionality." (Kuehnle at Col. 1, lines 7-10). Thus, the Kuehnle reference is from a different field of endeavor and hence does not qualify as analogous art under the first prong of the test.

The Kuehnle reference also is not reasonably pertinent to the particular problems with which the invention is involved – namely the growth of monocrystalline and polycrystalline silicon carbide crystals on a substrate for use in semiconductor applications. The Kuehnle reference has nothing to do with the problems which the present invention addresses; instead Kuehnle provides insights regarding how to collect a powder of a source substance where the particles of the powder are relatively uniform in size. Thus, the Kuehnle reference does not qualify as analogous art under the second prong of the test and, as such, the claims of the present application cannot properly be rejected based on the combination of the Pinkashov, Davis and Kuehnle references.

Finally, the Kuehnle reference does not relate to depositing silicon carbide on a substrate via electric arc sublimation. Instead, the Kuehnle reference is directed to an entirely different problem, namely, evaporating particles at a steady state so that the particles will cluster together at a consistent rate. Thus, the suggestions in Kuehnle regarding the gap to maintain between the electrodes is made in the context of a different art and directed to solving a different problem. The Davis reference, however, contains explicit teachings regarding controlling the flux between the silicon carbide source material and the silicon carbide seed. In particular, Davis teaches that the "if the thermal gradient is continually increased as the source powder is depleted and as the seed crystal grows, an absolute temperature differential between the source and the seed can be maintained at an amount which continues to be most favorable for growth." (Davis at Col. 9, lines 29-35). Davis further teaches that this can be accomplished by modifying the temperature of the source powder and/or the seed during growth and/or by changing the pressure during growth or by a combination of these methods. Applicant respectfully submits that the skilled artisan would look to the teachings in the Davis references regarding controlling the temperature and the pressure in the reactor to maintain a steady flux or the teachings of some other reference that actually relates to the field of the present invention. What the skilled artisan would not do is look to a completely different field to directly modify the teachings of a reference that the Office Action contends teaches the method of solving the problem addressed by the present invention. Consequently, the rejection of independent Claims 1 and 24 based on Pinkashov, Davis and Kuehnle should be withdrawn in light of the amendment of those claims to include the recitations of original Claim 6.

2. The Rejections Based on Pinkashov, Davis and Smalley

Claim 6 was also rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinkashov and Davis in view of Smalley. The Smalley reference relates to a method of producing fullerenes particles. Smalley does not teach or suggest the use of silicon carbide electrodes or electric arc sublimation of silicon carbide, but instead relates to a completely different material system and the use of an electric arc for an entirely

different purpose. As such, for reasons analogous to those discussed above with respect to the Kuehnle reference, there would simply be no reason or motivation for the skilled artisan to modify the Pinkashov reference using Smalley as suggested in the Office Action, and it is only through hindsight based on the teachings of the present invention that one would make any such modification. The Pinkashov reference also teaches away from the combination of references identified in the rejection, as Pinkashov teaches that the electrodes are repeatedly struck together and then separated, in stark contrast to the electrode setup in the Smalley reference. The Smalley reference, like Kuehnle, also is not analogous art, as it has nothing to do with semiconductor growth techniques or particular problems associated with the growth of silicon carbide crystals. Finally, like the Kuehnle reference, Smalley is unrelated to depositing silicon carbide on a substrate via electric arc sublimation and hence the skilled artisan would be motivated to look to the Davis reference to ascertain how to maintain constant flux instead of the completely unrelated Smalley reference. Accordingly, amended Claims 1 and 24 are likewise patentable over the combination of the Pinkashov, Davis and Smalley references.

D. Independent Claim 33 is Patentable Over the Cited Art

As noted above, independent Claim 33 has been amended to recite that the electric arc is used to "create a local high temperature zone within the furnace . . . while maintaining the inner walls of the furnace at a temperature below the temperature at which silicon carbide sublimates." Applicant respectfully submit that none of the cited references teach or suggest "using resistive or inductive heating to heat a furnace" while at the same time "creat[ing] a local high temperature zone within the furnace . . . while maintaining the inner walls of the furnace at a temperature below the temperature at which silicon carbide sublimates." (*See* Claim 33). For instance, the Davis reference teaches heating the furnace walls to a temperature above the temperature at which silicon carbide sublimates. (*See, e.g.*, Davis at Col. 11, lines 20-23). Pinkashov does not teach or suggest that a furnace is even provided, as the electric arc is used solely to perform the vaporization. (*See* Pinkashov at Col. 4, lines 5-41). Kuehnle teaches that a "cold" inert gas is flown just

inside the housing sidewall, indicating that in Kuehnle the housing is actually cooled as opposed to heated. (*See* Kuehnle at Col. 4, lines 3-12). Accordingly, as the cited art fails to teach or suggest the recitations of Claim 33, the rejection of Claim 33 should also be withdrawn.

E. The Dependent Claims are Patentable Over the Cited Art

Each of the dependent claims are patentable for the reasons stated above with respect to the independent claims from which they depend. Additionally, various of the dependent claims are independently patentable over the cited combinations of prior art references.

For instance, Claims 11 and 15 recite that "the substantially constant pressure level is pre-selected for growth of a pre-selected polytype of silicon carbide." While the Office Action rejected original Claims 11 and 15 based on the combination of Pinkashov and Davis, neither of these references teach or suggest pre-selecting a pressure level for growth of a pre-selected polytype of silicon carbide. Accordingly, Claims 11 and 15 are independently patentable over the cited art for at least these additional reasons.

Likewise, Claim 12, which stands rejected based on the combination of Pinkashov and Davis, recites "raising the temperature of the silicon carbide electrode to a temperature lower than the temperature at which silicon carbide sublimates." Neither the Pinkashov or Davis reference provides any such teaching. Specifically, the Davis reference fails to even disclose an electrode and, in any event, teaches heating the silicon carbide source material to a temperature above the temperature at which silicon carbide sublimates. Pinkashov does not teach raising the temperature of the silicon carbide electrode at all, aside from the temperature increase that is caused by the electric arc vaporization, and that temperature increase is, again, to a temperature above the temperature at which silicon carbide sublimates. Accordingly, Claim 12 is also independently patentable over the cited art for at least these additional reasons.

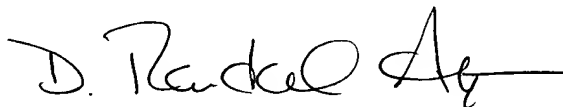
Claim 14 recites that "the internal temperature of the sublimation system, the position of the silicon carbide electrode and the second electrode, a voltage drop

across the gap and a current conducted across the gap are configured so as to maintain the end of the silicon carbide electrode adjacent the gap at a substantially constant temperature during the sublimation process." Claim 30 contains a similar recitation. While the Office Action states that the combination of Pinkashov and Davis in view of either Kuehnle or Smalley teaches these recitation, Applicant respectfully disagrees. Pinkashov discloses a process where the temperature at the end of the electrode will vary (*i.e.*, not remain constant), and Davis teaches that the temperature of the silicon carbide source material is varied throughout the sublimation process. The Kuehnle and Smalley references are silent regarding the temperature at the end of the electrode, and hence do not provide the necessary teaching. In any event, even if Kuehnle or Smalley taught the recitations of Claims 14 and 30, no motivation has been identified for modifying the primary references – each of which teach away from maintaining the ends of the electrodes at a constant temperature – in this manner. Accordingly, Claims 14 and 30 likewise are independently patentable over the cited art for at least these additional reasons.

CONCLUSION

Applicant submits that the present application is in condition for allowance and the same is earnestly solicited. Should the Examiner have any matters outstanding of resolution, he is encouraged to telephone the undersigned at 919-854-1400 for expeditious handling.

Respectfully submitted,



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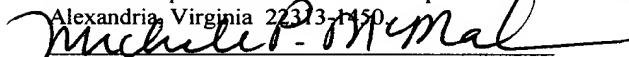
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PATENT TRADEMARK OFFICE

In re: Thomas G. Coleman
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Page 19

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Michele P. McMahan

Date of Signature: May 1, 2003